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Patents Form 1/77

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

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Cardiff Road
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1. Your reference — 2/11190.GB

2. Patent application number *(The Patent Office will fill in this part)* — 9721746.7

15 OCT 1997

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Panos Therapeutics Limited
The Doctor's House
HighStreet
Little Milton
Oxford OX44 7PU

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — England

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4. Title of the invention — COMPOSITIONS

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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S&Co

Patents ADP number *(if you know it)* — 1446001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
N/A		

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*
N/A	

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or

b) there is an inventor who is not named as an applicant, or

c) any named applicant is a corporate body.

See note (d)) — Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	16
Claim(s)	---
Abstract	---
Drawing(s)	---

10. If you are also filing any of the following, state how many against each item.

Priority documents	---
Translations of priority documents	---
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	---
Request for preliminary examination and search *(Patents Form 9/77)*	---
Request for substantive examination *(Patents Form 10/77)*	---
Any other documents *(please specify)*	---

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 14/10/97

Sanderson & Co.

12. Name and daytime telephone number of person to contact in the United Kingdom Mrs. J. D. Barrett-Major 01206-571187

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Notes

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Compositions

The present invention relates to pharmaceutical formulations suitable for treating pain, in particular, neuropathic pain and/or dysesthesia, and their preparation. In particular, the present invention relates to formulations comprising a cholecystokinin antagonist and an opioid.

Cholecystokinin (hereinafter 'CCK') has been implicated in a variety of physiological functions, one of which is the control of pain. CCK has been shown to have a heterogeneous distribution within the brain, with the greatest levels being found in the hippocampus, cerebral cortex, amygdala and olfactory lobes. The physiological role of central CCK receptors is still under investigation, but it has many of the features of a neurotransmitter. CCK has been found in regions of the brain known to be associated with pain modulation. Furthermore, mole-per-mole, CCK has been found to be much more potent than morphine in tests for analgesia.

However, at variance with these findings, are results of tests which imply that CCK may antagonise endogenous opiate action, (Faris et al. in Science 219 310-2 (1983)). There is evidence that exogenous CCK attenuates analgesia induced by morphine or release of endogenous opioids. These disparate

findings and others imply that large doses of CCK induce a 'pharmacological' analgesia whereas small doses of the peptide produce physiological antagonism of opioid analagesics.

CCK also appears to play a rôle in the development of tolerance to opioid analgesia as blockade of CCK receptors has been shown to prevent tolerance to morphine. Hence, blockade of CCK receptors by CCK antagonists may reverse or prevent the development of opiate tolerance in patients, and also potentiates the analgesic effects of opioids. The present invention is therefore based on the thesis that blockage of CCK action may be an effective supplement to morphine (or other opioid) administration in the treatment of chronic pain. However, it is believed that this opioid facilitation is preferentially mediated by the central CCK type B receptors since CCK-B antagonists seem to potentiate the analgesic effects of both opioids and non-opioids at the spinal level. Furthermore, facilitation of opiate-induced analgesia by CCK-B receptor antagonists seem to be restricted to μ-, rather than δ-, opioid receptor-mediated antinociception. Such μ-opioid againsts include morphine and hydroxymethyl fentanyl. However, potentiation of the analgesic effects produced by these opioids has also been observed with (relatively higher doses of) a CCK-A antagonist.

The present invention therefore generally relates to pharmaceutical formulations comprising an opioid-potentiating amount of a CCK antagonist together with an analgesic amount of an opioid. However, although the most popularly-used opioids such as morphine are not difficult to formulate, particularly for administration by injection, as they are water-soluble drugs, many CCK antagonists, particularly the preferred CCK antagonists to which this invention relates, are relatively insoluble compounds which are therefore pharmaceutically incompatible with hitherto-known formulations of opiate drugs. Having therefore taken the step of appreciating the advantages to be gained by co-administration of an opioid with a CCK antagonist in a single formulation, it was then realised that such a formulation, or a satisfactory carrier for the combination of active ingredients, was not available.

The present invention is therefore directed at solving this problem and provides a pharmaceutical formulation comprising

(a) an opioid-potentiating amount of a CCK antagonist;

(b) an analgesic amount of an opioid; and

(c) a pharmaceutically acceptable biphasic carrier comprising

(i) an organic phase comprising a glyceride derivative; and

(ii) a hydrophilic phase.

The organic phase may be either solid or liquid at room temperature but preferably has a solubilising capacity for the CCK antagonist in excess of 5mg per gram of organic phase. Examples are oils comprising a glyceride which is liquid at room temperature and glyceride waxes having melting points in the range 35-80°C.

The organic phase may therefore comprise, for example, soya bean, safflower, sesame, rapeseed, peanut, olive, cotton seed or fish oils. Preferably, soya bean and/or safflower oils are chosen, alone or in combination with glycerine. Alternatively, the organic phase may comprise waxes such as full and/or partial glycerides of fatty acids. Preferably, such waxes are triglycerides and partial glycerides of unsaturated C_{12-18} fatty acids such as, for example, Witepsol H15 or W25.

The hydrophilic phase may itself be aqueous, or may be anhydrous but take in and/or dissolve in water in vivo. In the case of formulations for intravenous use, the hydrophilic phase preferably has a viscosity of from 2500-7500cp (2% aqueous at 20°C), more preferably around 4000cp. Such ingredients may also be added to prevent or reduce coalescence of oily droplets of the organic phase. In the case of solid formulations such as tablets and suppositories, the hydrophilic phase is gel-forming and incorporates the

opioid in the gel, and also forms a matrix for incorporating the CCK antagonist plus glyceride. The hydrophilic or aqueous phase may therefore comprise a pharmacologically and pharmaceutically acceptable polymer or salts thereof which may be selected from proteins such as gelatine, hyaluronic acid, alginic acids or salts thereof such as sodium alginate, carboxymethylcellulose (optionally cross-linked), methyl cellulose, other cellulose derivatives which are water-swellable such as hydroxypropylmethyl-cellulose and hydroxyethyl cellulose or other water-swellable polymers such as polyvinyl pyrrolidone (PVP) or water-soluble polymers such as lactose.

In the formulation, the organic and hydrophilic phases may be separated or may be combined, for example, to form an oil-in-water emulsion. Preferred such emulsions therefore comprise:

(i) an oil phase comprising a glyceride derivative; and

(ii) an aqueous phase optionally comprising a buffer whereby the emulsion has a pH of from 6.5 to 7.5 and optionally comprising an isotonicity regulator whereby the aqueous phase is made isotonic to blood plasma.

When the carrier is in the form of an emulsion, the average particle size of the resultant emulsion is preferably in the range 0.2 to 3.0μm, more preferably

around 1μm.

Optionally, an emulsifying agent and/or surfactant may be incorporated into the carrier. A suitable surfactant is a sorbitan derivative such as the polysorbates, for example polysorbate 80, or sorbitan mono-oleate, and the poloxamers such as Pluronic F38. Suitable emulsifying agents include egg yolk lecithin, egg yolk phospholipids such as phosphatidyl choline and the like.

To adjust the pH, a suitable pH adjuster (i.e. an acidifying or alkalising agent) is used such as hydrochloric acid or sodium hydroxide, or a buffer such as a phosphate buffer system. Preferably, the pH is adjusted to 7-7.5, more preferably, it is close to neutral (pH = 7).

Liquid formulations may also comprise an isotonicity regulator to ensure that the aqueous phase thereof is or remains isotonic to blood plasma. Examples of such isotonicity regulators include dextrose, glucose, mannitol, sorbitol, glycerol and sodium chloride.

Other hydrophobic or hydrophilic components may be included in the formulation such as, particularly in the case of suppositories, a thickener or gelling agent for the organic phase such as hydrophobic silicon dioxide or silica; lubricants, particularly in the case of tablet formulations, such as magnesium stearate,

stearic acid, talc and LUBITROL, preferably magnesium stearate. Optional other ingredients include colouring or flavouring agents, release agents, pore-forming agents, stabilisers, and fillers or diluents such as lactose, calcium phosphate or carbonate, microcrystalline cellulose and the like, and antioxidants.

Also, in the case of tablets, a coating may be applied such as waxes, fatty alcohols, water-insoluble cellulose derivatives, other water-insoluble polymers such as polymers or copolymers of acrylates and/or methacrylates (eg. EUDRAGIT), ethylcellulose, cellulose acetate, shellac, hydrogenated vegetable oils and the like. Such a coating may provide the mechanism to enable controlled release of the opioid. Such a coating may optionally include a plasticizer or film enhancer such as monoglycerides, phthalates, sebacates, citrates, castor oil and the like.

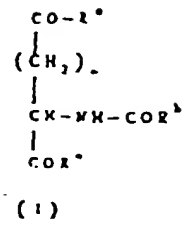
Preferably, the CCK antagonist is incorporated into the organic phase, and more preferably into the glyceride derivative, and the opioid analgesic is incorporated into the hydrophilic phase. However, the present invention does not preclude having components (a) and (b) present in any combination in any phase of the carrier.

The components are preferably present within the following ranges of ratios: 10:1 to 1:5, respectively

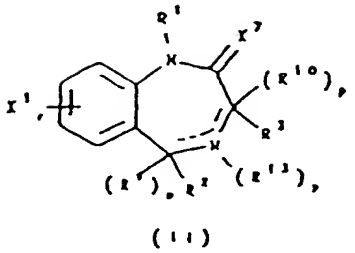
(i):(ii); and 1:2 to 1:40, respectively (a):(b).

The opiate drug may be selected from those which are effective analgesics and particularly those which need to be administered at relatively high or increasing doses. Examples include morphine, or a salt thereof such as the sulphate, chloride or hydrochloride, or other 14-hydroxymorphinan opioid analgesics such as naloxone, meperidine, butorphanol or pentazocine, or morphine-6-glucuronide, codeine, dihydrocodeine, diamorphine, dextropropoxyphene, pethidine or fentanyl, or a salt of any of these.

The CCK antagonist may be selected from any of those which potentiate the analgesic effects of the opioid chosen and/or which reverse or prevent patient tolerance thereto. For example, CCK antagonists include those of formulae (I)-(IV) which are defined, respectively, in (I) US 4791 215; (II) EPs 167 919 and 284 256; (III) EP 405 537; and (IV) J. Med. Chem. 34 1508 (1991), which are herein incorporated by reference in their entirety.



(I)



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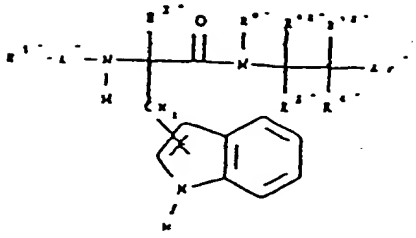

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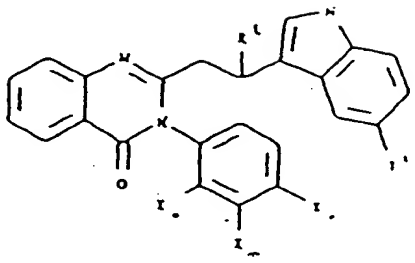

(IV)

Preferred CCK antagonists are selected from those described in European patents specifications nos. 167 919; 284 256; 508 796; 652 871; 411 668; 421 802; and 617 621, which are herein incorporated by reference in their entirety. Particularly preferred CCK antagonists include devazepide (also known as MK-329), namely, 3S-(-)-(1,3-dihydro-3-(2-indolecarbonylamino)-1-methyl-5-phenyl-2H-1,4-benzodiazepin-2-one (a CCK-A antagonist); L-365,260, namely 3R-3-(N'-(3-methylphenyl)ureido)-1,3-dihydro-1-methyl-5-phenyl-2H-1,4-benzodiazepin-2-one (a CCK-B antagonist); and so-called second generation compounds such as L-369,466, namely N-[1,3-dihydro-1-methyl-2-oxo-5-phenyl-1H-1,4-benzodiazepin-3-yl]-N'-[3-(1,2,4-oxodiazol-5-one)phenyl]urea, L-741,528, namely (-)-N-[2,3-dihydro-5-(4,4-dimethylpiperidin-1-yl)-1-methyl-2-oxo-1H-1,4-benzodiazepin-3-yl]-N'-[indan-5-yl]urea and [N-[(3R)-5-

(3-azabi-cyclo[3,2,2]nonan-3-yl)-2,3-dihydro-1-methyl-2-oxo-1H-1,4-benzodiazepin-3-yl]-N'-(3-methylphenyl) urea] (L-740,093, a CCK-B antagonist described in Molecular Pharmacol. 46 943-8 (1994)). Especially preferred are the CCK-B antagonists, in particular L-365,260 and the previously-mentioned second generation compounds.

The formulations of the present invention are preferably sustained-, slow- or continuous-release (S.R.) solid formulations, or emulsions for injection. S.R. formulations may be in the form of a suppository or tablet, for example.

The formulations of the present invention are particularly suitable for treating chronic and neuropathic pain. Nerve damage arising from either trauma or disease affecting peripheral nerves leads to abnormal pain states referred to as neuropathic pain. Such pain may be long-lasting and continue for extended periods after the initial injury has healed. Individuals afflicted with neuropathic pain show a marked sensitivity to nociceptive stimuli, indicative of a lowered nociceptive threshold (hyperalgesia). Moreover, there is also a perception of normally innocuous stimuli being nociceptive, a state referred to as allodynia.

In particular, these formulations are suitable for treating patients with spinal cord injury. They

prevent tolerance to the opioid analgesic and eliminate the need to increase doses of opioid to clinically unacceptable levels. However, they are also useful in enhancing opioid analgesia in non-pathological pain states, and the anxiolytic (anti-anxiety or anti-panic) effects of some CCK antagonists is a particularly beneficial additional effect.

A suitable daily dose of CCK antagonist in these formulations would preferably be in the range 0.5 to 300mg per day, such as 1 to 100mg/day (oral or via suppository) or 1 to 300mg/day (i.v.). Preferably, for MK-329, the dose would be 1-10mg/day (5-10 mg/day orally or 1-3mg/day i.v.); for L-365,260, the dose would be 10-100mg/day orally (5-10mg/day orally or 10-300 mg/day i.v.); and for 'second generation' CCK antagonists, 1-2mg/day (oral) or 0.5-1.5 mg/day (i.v.).

The present invention will now be illustrated by the following non-limiting examples:

Example 1 : Intravenous Emulsions

(a)	L-740,093 (active (a))	0.00025g
	Morphine sulphate (active (b))	0.010g
	Soya bean oil (i)	0.4000ml
	Phosphatidyl choline (emulsifier)	0.0240g
	Pluronic F 68 (surfactant)	0.0040g
	Water (ii)(adjusted to pH 7 to 7.5 and made isotonic with sorbitol q.s.)	2ml

The injection is prepared using aseptic techniques and sterile materials. The MK-329 is dispersed in the soya bean oil and the morphine is dissolved in the water. The two phases are emulsified using standard pharmaceutical technology and stabilised by the phosphatidyl choline and Pluronic F 68. The amount of morphine sulphate may be altered to provide a range of potencies. A 2ml bolus intravenous injection may be administered every four hours, or the formulation may be incorporated into the reservoir of an analgesic self-administration device.

		1g ≡ 1ml
(b)	MK-329 (a)	0.0015g
	Fentanyl citrate (b)	0.0024g
	Soya bean oil (i)	0.0993g
	Safflower oil (i)	0.0993g
	Phosphatidyl choline (emulsifier)	0.0125g
	Glycerine	0.0200g
	Water (qs 1 ml) (ii)	0.7665g
	qs 0.1 N NaOH to adjust pH to 7.0 - 7.5	

The ingredients were mixed together and emulsified in a similar manner to that described above in Example 1(a).

Example 2 : Intravenous Infusions

(a)	MK-329 (a)	0.015g
	Morphine sulphate (b)	0.100g
	Cottonseed oil (i)	200ml

Polysorbate (surfactant)	1.6g
Fractionated egg phospholipids (emulsifier)	12.000g
Hydroxypropyl methylcellulose (ii)	5.000g
Water (ii) (adjusted to pH 7 to 7.5 and made isotonic with sorbitol)	1000ml

The MK-329 is dispersed in the oil phase and the fentanyl citrate is dispersed in the aqueous phase. The emulsion is formed using standard pharmaceutical techniques. One litre of emulsion may be adminstered intravenously over a 24-hour period. The amount of morphine may be adjusted to allow a range of doses, depending on the response of individual patients.

(b)	L-365,260 (a)	0.03g
	Morphine sulphate (b)	200mg
	Soya bean oil (i)	100g
	Egg yolk lecithin (emulsifier)	12g
	Glycerine (i)	25g
	Gelatine (ii)	50 g
	Water q.s. to (ii)	1 litre

All the ingredients are emulsified together, except the gelatine, at 80°C. The temperature is reduced to about 40°C and the gelatine added.

Example 3 : S.R. Suppository

Butorphenol tartrate (b)	30mg
MK-329 (a)	12mg

Hydroxypropyl methylcellulose (ii)	300mg
Aerosil R972* (thickener)	100mg
Witepsol H15 or ((i), glycerides) Witepsol W25 to	2500mg

(*Hydrophobic silica)

The MK329 and Aerosil are added to molten Witepsol. The butorphenol is blended with hydroxypropyl methylcellulose and then added to the Witepsol mixture. The mixture is poured into 3 ml moulds and shock cooled to room temperature.

Example 4 : Coated S.R. Tablet

(a) Core

MK-329 (a)	0.015g
Suppocire DM (((i), glyceride*)	0.100g
Levorphanol tartrate (b)	0.006g
Crosslinked polyvinyl pyrrolidone (PVP) (ii)	0.010g
Lactose (ii)	0.175g

Coating

Cellulose acetate	0.020g

(b) Core

Dihydrocodeine tartrate (b)	180mg
Suppocire DM ((i), glyceride)	100mg
L-741,528 (a)	4mg
Polyvinylpyrrolidone (PVP) (ii)	40mg
Lactose (ii)	123mg
Magnesium stearate (lubricant)	1.5mg

* Suppocire DM is a mixture of hemi-synethetic glycerides of C_{12-18} saturated with fatty acids.

Coating

Hydroxypropyl methylcellulose (ii)	14.45mg
Triethyl citrate (plasticiser)	6.9mg
30% aqueous dispersion	
ethyl cellulose	17.21mg
Purified water	q.s.

The dihydrocodeine tartrate is dispersed in molten Suppocire which is cooled with constant stirring to give a granular product. These granules are blended with other materials and tableted.

Example 5 : S.R. Tablet

L-740,093 (a)	0.002g
Suppocire DM ((i), glyceride)	0.100g
Dihydrocodeine tartrate (b)	0.180g
Magnesium stearate (lubricant)	0.003g
Hydroxypropyl methyl cellulose (ii)	0.250g
	0.548g

The L-740,093 is dissolved in molten Witepsol W25 at 50-60°C. The resulting liquid is atomised into a chamber containing chilled nitrogen (gas) at about 10°C. Spherical particles produced thereby are in the range 80-120 μm. These are then blended with the dihydrocodeine tartrate and remaining excipients to

produce a powder which is tabletted by standard techniques.

Example 6 : S.R. Capsules

L-369,466 (a)	0.0004g
Morphine sulphate (b)	0.100g
Suppocire DM ((ii), glyceride)	0.200g
Sodium alginate (i)	0.200g

The L-369,466 and morphine are incorporated into molten Witepsol. Granules or spheroids are produced by standard pharmaceutical techniques, then blended with the sodium alginate before filling into capsule shells. The amount of morphine in each capsule, for once daily administration, can be changed within the range 30mg to 150mg.

P.T.

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